Undergraduate Synthetic Biology course Syllabus:

Class Format

The Class will meet twice a week, one 2 hour classroom session, and one 3 hour lab session.

Problem sets will be assigned alternate weekly

A midterm exam will cover the classroom material and the first 8 weeks of lab instruction.

Lab exercises will be assigned, and cover the lab techniques taught.

A small project to assemble and measure a BioBrick system follows the lab instruction. Finally, students will design, build and analyze their own BioBrick system. (The Registry of Standard **Biological** Parts is a collection of parts: sequences of DNA with specific function that can be combined together to implement more complex functions. These parts are called **BioBricks**.)

Marking Scheme

The final grade will be as follows:

10% Problem Sets (we can have literature review or assignments as well)

10% participation during lecture (I think we need to put these 10% as participant because the workload without that seems heavy)

30% Midterm Exam

20% Lab Evaluations

30% Final Project (or we can just do final exam)

Lecture Outlines

- Introduction to synthetic biology
    - Foundation of synthetic biology
        - what you might have already heard about SB through the mainstream news
        - Seminal papers (oscillator + toggle switch)
        - Overview of the current research work + areas of application
        - Let's try to define Synthetic Biology (special focus on how SB differs from traditional genetic engineering)
        - Overview on the Foundations for Synthetic Biology (Abstraction / Modularity, Standardisation, and Characterisation / Quality Control) - concepts will be developed further in later lectures
        - Synthetic Biology Community

        - Ethics and Impact on Society

- **BioBricks: a standard for physical DNA composition**
    - Quick review on the traditional recombinant DNA toolbox + ad hoc cloning strategy
    - Advantages of a standardised cloning approach (systematic approach + modularity/abstraction)
    - BioBrick standard definition + concept of the Registry
    - Standard assembly process
    - How to build a BioBrick part (from PCR or DNA synthesis)
    - Other emerging BioBrick standards
    - 3 antibiotic assembly
- **PoPs and RiPs: transcriptional device standards for functional composition**
    - Quick refresh on gene expression using BioBrick parts: transcription / translation / DNA-binding protein
    - Abstraction layers: DNA --> Promoter / RBS / ORF / Terminator --> Protein Generator / Genetic Inverter
    - Standard biological information flow : Polymerase per second (PoPS), Ribosomes per second (RiPS)
    - Modular inverter design (RiPS based or PoPs based)
    - Modular and re-usable designs
- **Biological part characterisation and quality control**
    - importance of quality control and characterisation in Engineering (examples from electronic / mechanical systems)
    - Checking DNA integrity
    - BioBrick characterisation (promoter, RBS, Protein ...) + concept of a Registry of standard biological parts.
    - Review on BioBrick F2620 chacacterisation
    - Chassis characterisation
- **Designing a biological system from BioBricks**
    - To give to the students an idea of the workflow involved in an iGEM-type project
    - Main areas of research (Bio-energy, Bio-sensors, information processing, Drug development, Bio-material ...)

- development cycle: Specifications, Design, Modelling, Implementation, testing/validation
- Available resources to start with
- Searching the registry and the literature

If we do have pre - requisite for this course and it's most likely 300 level course we can have BIO130 + BIO230 as pre-requisite and most student suppose to know some of these lab techniques and we'll give a review as well and make them more expert:

(Basic) Laboratory Techniques (of molecular biology)

- DNA cloning
  - *cut and paste* DNA
  - bacterial transformatio
    - Transfection
    - chromosome integration cellular screening
  - cellular culture
  - extraction of DNA
- Polymerase Chain Reaction
  - DNA polymerase DNA dependent PCR dynamics
  - PCR types
- Gel electrophoresis
- reading and writing DNA DNA sequencing
  - DNA synthesis
  - DNA sequencing
- molecular hybridization
  - Southern blot

- Northern blot
- Western blot

- rewriting DNA : mutations
  - random mutagenesis
  - point mutation
  - chromosome mutation
- Arrays
  - DNA array
  - protein array

- Some possible textbook for the undergrad course:
  - Synthetic Biology — A Primer: Revised Edition
    - Synthetic Biology — A Primer (Revised Edition) presents an updated overview of the field of synthetic biology and the foundational concepts on which it is built. This revised edition includes new literature references, working and updated URL links, plus some new figures and text where progress in the field has been made.

  - Synthetic biology handbook:
    - Darren N. Nesbeth
      The Synthetic Biology Handbook explains the major goals of the field of synthetic biology and presents the technical details of the latest advances made in achieving those goals. Offering a comprehensive overview of the current areas of focus in synthetic biology
    -
  - Synthetic Aesthetics: Investigating Synthetic Biology's Designs on Nature
    - Synthetic biology manipulates the stuff of life. For synthetic biologists, living matter is programmable material. In search of carbon-neutral fuels, sustainable manufacturing techniques, and innovative drugs, these researchers aim to redesign existing organisms and even construct completely novel biological entities. Some synthetic biologists see themselves as designers, inventing new products and applications.